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## THE LARVA OF THE CADDIS FLY, MOLANNA CINEREA HAGEN.

BY C. BETTEN.

### HISTORICAL.

The material upon which this study is based was all collected at Saranac Inn, New York. For the most part, the specimens were taken from Little Clear Creek—the outlet of Little Clear Lake, one of the innumerable beautiful lakes of the Adirondacks. In this region caddis flies were found to be very abundant. During the ten weeks succeeding June 15, 1900, almost a score of different larvæ were found, while upwards of thirty species of adults were caught. Of the latter the greater number were secured by means of trap lanterns. Conspicuous among these many species was *Molanna cinerea* Hagen, the subject of this study. The interesting character of this larva, the fact that it was successfully reared, and above all, its presence in such large numbers, were the considerations that led to its selection for a more detailed study.

The amount of work already done along this line is exceedingly small. In fact the Trichoptera are a somewhat neglected order. For the adults, to be sure, we have MacLachlan's\* great monograph of the European fauna. The immature stages however have received scarcely any attention. Their natural history is fairly presented in Miall's Natural History of Aquatic Insects. This account consists almost exclusively in extracts from the work of Reaumur. Professor Patten† gives us the embryology of one species. Professor K. J. Morton,‡ F. J. Pictet,§ Fr. A. Kolenati|| and Miss Cora Clarke¶ are among those who have described various species. The glands of

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\* MACLACHLAN, ROBERT. A monograph revision and synopsis of the Trichoptera of the European Fauna. 1879.

† PATTEN, WILLIAM. The Development of Phryganids. Three pl. Quart. Journ. Micros. Sc., Vol. XXIV, pp. 549-602.

‡ MORTON, K. J. Notes on the Metamorphosis of British Leptoceridæ. 1890. Entomol. Month. Mag., Vol. I, No. 5, pp. 127-131.

§ PICTET, F. J. Recherches pour servir à l'histoire et l'anatomie des Phryganides. Genève and Paris, 1834.

|| KOLENATI, FR. A. Genera et Species Trichopterorum. Pars I, Praga, 1848, Pars II. Mosquæ, 1859.

¶ CLARKE, CORA H. Caddis flies of Stony Brook. Psyche, 1891. P. 153.

the thorax have been carefully studied by Professor Gilson\* and M. Maurice Henseval.† They reach the conclusion that these glands have a nephridial function. Professor Lucas‡ presents a detailed account of the metamorphosis of the mouth parts and salivary glands of *Anabolia furcata*.

The most complete work on life histories is that of Professor Franz Klapálek,§ of Prag. This contains a general description of the cases, larvæ and pupæ of European Trichoptera. The body of the work consists of the description of the cases, larvæ and pupæ of forty-three species previously practically unknown. A statement of family characteristics makes this the best if not the only work available for the determination of immature caddis flies. Dr. Georg Ulmer is at present engaged with a similar work on the Trichoptera of Germany. In this connection should also be mentioned Professor R. Struck's† paper on caddis fly cases, in which a table is given for determination by means of the cases. One of the species described by Professor Klapálek is *Molanna angustata* Curt., which seems to be a very close European relative of *Molanna cinerea* and much help has been derived from a comparison with this description. I have given a general account of this species with colored figures of all stages and of the case in Bulletin 47 of the New York State Museum.

#### EXTERNAL ANATOMY.

*Larva*.—The larva of *Molanna cinerea* was found in abundance until about the middle of August. Up to that time they were obtained with the greatest ease by means of a sieve net drawn through the sandy bottom where little or no vegetation appeared. Both the adult and larva of this insect are striking examples of protective form and coloration. The former by its color and its habitual posture with abdomen tilted upward and closely wrapped by the wings, exactly simulates a

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\* GILSON, G. Journ. Micr. Soc. London, Pt. I, p. 30. Thoracic glands in larvæ of Trichoptera.

† HENSEVAL, M. MAURICE. Les glandes buccales des larves de Trichoptera. La Cellule, XII, pp. 1-12.

‡ LUCAS, R. Beiträge zur Kenntnis der Mundwerkzeuge der Trichopteren. Arch. f. Naturg., LIX.

§ KLAPELEK, FR. Metamorphose der Trichopteren, serie I and II, Archiv. der Naturwissensch. Landesdurchforschung von Böhmen, Band VI, No. 5 and Band VIII, No. 6.

|| STRUCK, R. Illus. Zeitschr. f. Entomol., Band IV, Nos. 8, 10, 17, 19, 20, 21.

splinter or snag of wood, while the case of the latter, being made entirely of sand, could hardly be discovered, even if moving about in clear shallow water. This case consists of a slender tube with a wide sheath extending beyond on all sides, but farthest at the anterior end. It is therefore of a flat conical shape, rounded at both ends, with the greatest diameter at the anterior opening of the tube. Its length is 20 mm., its width 10 mm. Professor Klapálek says that before pupation the larva of *Molanna angustata* removes the forward part of the sheath and that the sides are also often much narrower than in the larval stage. Such a condition of the case was frequently observed in *Molanna cinerea*, but was not invariable, and might at all events be due, in part at least, to the natural wearing away of the case which can no longer be repaired by the occupant.

The larva is slender, with its head at an angle with the main axis of the body. Its length is 12 mm., its width 2 mm. The head and thorax are of a yellow color. The sutures of the head are bordered with black, forming with the suture of the pronotum a large Y, the arms of which join near the rear of the head. The antennæ stand just posterior to the bases of the mandibles. They consist of two joints — a broad conical one at the base, and a second shorter one which is in turn surmounted by a stout bristle of about its own length. The mouth parts are well developed. The labrum is of elliptical form — the forward edge almost straight. The mandibles are very strong, carrying two and three teeth on the right and the left side respectively. Along the outer edge of each mandible, stand two long bristles. The gula is a trapezoid in shape, longer than broad. It is of a dark brown color. The labium is thickly set with hairs at its base. The maxillary palpi are of a conical shape and are closely applied to the maxillæ. Each palpus has four joints, only the last extending beyond the maxillæ. On the inner edge of the maxillæ are three stout bristles. The labium is conical in shape, carrying on each side of its point a three-jointed palpus. At its very tip the opening of the salivary (silk) glands may be seen.

The thorax is of the same color as the head. The pronotum is more heavily chitinized than the other divisions. Its anterior edge is gently arched. The posterior edge forms two arches, the incision between which is continued to form the longitudinal suture almost to the anterior edge. The entire posterior edge is margined with black. The forward half of the mesonotum is covered with a chitinous shield which

is divided longitudinally into two parts. Along this division are numerous brown patches. The rear half also has a brown spot just forward of its center.

The legs are yellow with the adjoining edges of coxa and trochanter black. The first pair is the shortest. It has many spurs along its inner edge. One is found at the distal end of the trochanter, three on the femur besides one at its distal end, one is placed on a distinct prominence near the end of the tibia, while a row of smaller ones runs obliquely across this joint. The tarsus carries one spur and still another is located at the base of the single claw. On the second pair of legs we find one spur on the distal end of the trochanter, ten along the inner edge of the femur with a stout one at the middle of the row, one on a prominence on the tibia, two on the tarsus and one at the base of

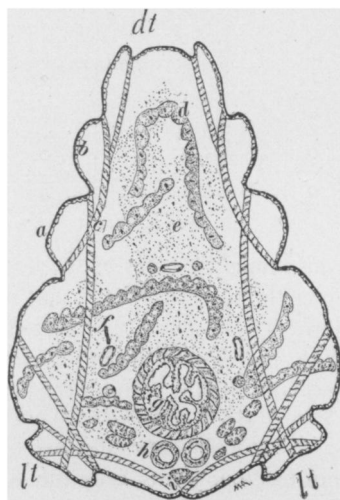


FIG. 1. Semi-diagrammatic cross-section of the larva through the first abdominal segment; *dt*, dorsal tubercle; *lt*, lateral tubercles; *a*, chitin; *b*, hypodermis; *c*, dorso-ventral muscles; *d*, fat masses; *e*, blood; *f*, malpighian tubules; *g*, crop; *h*, salivary glands; *i*, nerve cord. Drawing by Miss Maud H. Anthony.

the claw. The femur also carries numerous hairs on its outer edge. The third and longest pair of legs are quite different from the others. The large spurs are wanting, only the femur has its inner edge covered with black spines. The end of the tarsus is covered with a brush of thick hairs so that no claws can be distinguished. The femur has a

transparent spot at its center. This pair of legs is more hairy than the others.

The abdomen of the larva is of a light color tinged with brick red. The first segment has three tubercles (Fig. 1), the upper one by far the largest. Respiratory filaments occur on six of the nine segments. They are placed at the forward edge of the segments, in two rows on both dorsal and ventral sides. Their number and position may be represented diagrammatically by the accompanying figures.

Dorsal side.		Ventral side.	
0	0	0	0
4	4	3	3
4	4	3	3
4	4	3	3
3	3	2	2
2	2	2	2
2	2	0	0
0	0	0	0
0	0	0	0

A fringe of hairs runs along the sides of the body from the third to eighth segment. Along the latter segment, the fringe consists of very stiff hairs set in pairs. The body is terminated by a pair of two-jointed prolegs. These carry strong hooks which point outward. At the base of each of the large hooks are two smaller ones.

#### INTERNAL ANATOMY.

The larva was found to be quite unfavorable for gross dissection, hence for the study of internal structure reliance has been placed chiefly upon microtome sections which were prepared by the ordinary methods.

The alimentary canal consists, as is usual, of mouth, gullet, crop, stomach, intestine and rectum. The second of these divisions is about straight; its walls are not convoluted and are surrounded by strong circular muscles. This division extends to the prothorax. The crop extends through the remainder of the thorax. Its strong walls are much convoluted, and its circular muscles are of great size, especially near the opening into the stomach. The region from

the thorax to the middle of the sixth segment is occupied by the stomach. Here the circular muscles are smaller than around any other part of the canal. The stomach epithelium is arranged in regular folds with nests of regenerative cells between them. The stomach was found to be infested with Gregarinidæ which closely resembled the young *Clepsidrina* figured in Bronn's *Klassen und Ordnungen*.\* The intestine extends to the middle of seventh segment. Its epithelium is arranged in six longitudinal ridges or cushions with thinner parts alternating. The cells of the cushions and their nuclei are large. The rectum occupies the remaining segments. The inner walls are much convoluted except in the last segment in which they are quite straight. Its epithelium is made up of very large cells.

In late larval stages the metamorphosis of the stomach may be observed. The epithelium is cast off entire and is seen lying in the center of the canal. In its place there has developed a very even and thin epithelium. The six cushions again appear in the intestine as do also the large cells in the rectum.

The malpighian tubules enter the alimentary canal near the point where the stomach passes over into the intestine. They are six in number and extend in many loops through every segment of the abdomen.

The salivary glands occupy a conspicuous place in the internal structure of the larva. They extend through the greater part of the abdomen, lying in three main loops. Throughout the thorax they appear as two straight tubes lying under the alimentary canal. Between the subœsophagal and the first thoracic ganglion of the nervous system they pass below the nerve cord. The glands unite at the base of the labium and open as a single tube. In this part lies the apparatus for shaping the silk, which is minutely described by Lucas, in the work referred to above. A smaller pair of glands is found in the head, lying folded under the œsophagus.

The nervous system of this larva is very simple. Professor Klapálek speaking of Trichoptera in general says there are eleven ganglia besides those of the head. In this larva ganglia were found in only six of the abdominal segments, making a total of nine besides the subœsophagal and supræœsophagal ganglia. Whether this is an exception to the general rule or whether the preparations were defective, is impossible to decide.

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\* BRONN'S *Klassen und Ordnungen des Thier-Reichs*, Vol. I, Pl. 35, Fig. 9.

The blood system is likewise simple. The main blood vessel is easily distinguishable along the dorsal side. In cross section it appears triangular. Throughout the body there is a great deal of free blood.

The reproductive system is fairly well developed in the larva. The ovaries and spermaries lie in the fourth abdominal segment.

Mention should also be made of the numerous large oenocytes which lie near the body wall throughout a great part of the abdomen, and of the wing buds which appear very clearly in the mesothorax and metathorax as infoldings in the epithelium.

Reference has been made to the three tubercles on the first abdominal segment. It has long been known that these are retractile and protrusible and so serve to fix the position of the larva in its case and perhaps to regulate the flow of water through the case. How this movement is brought about has not been explained. The accompanying figure shows the simple muscular arrangement by which the retraction is accomplished. Besides these few muscles nothing was found in the tubercles, excepting blood and a small amount of fat. It is altogether probable that the protrusion is effected by a contraction of the body forcing the blood into the tubercles.

#### A NEW TYPE OF DERMAL GLAND.

We conclude our account of the larva with the mention of certain dermal glands (Fig. 2) which appear in the fourth, fifth, sixth, and seventh segments. Unless these glands are not common among the Trichoptera it is surprising that they should have remained unnoticed hitherto, for their size as well as the fine staining of which they are susceptible make them very prominent in sections made in any plane of the body. The dermal glands described by Andreas Martynow\* resemble these more than any others that are described. That they are essentially different, however, is shown by the following points of contrast: they occur in the posterior segments of the thorax and in all the abdominal segments, they are unicellular and they open through the chitin by means of a canal. The glands of *Molanna cinerea*, on the contrary, are composed of many cells and have no openings through the chitin. These glands are at the middle of the sides of the body in the lower angle formed by one of the dorso-ventral muscles and the body wall,

\* MARTYNOW, ANDREAS, Über einige eigenthümliche Drüsen bei den Trichopteren, Zoöl. Anz., XXIV, pp. 449-455, 5 figs.



and in the upper angle formed by another dorso-ventral muscle with the body wall. They lie near the anterior end of the segments named, a little above the middle of the body so that the lateral fringe crosses the glands below the center. The fact that they appear of the same shape in both frontal and sagittal sections would indicate that the glands are round. Their diameter was estimated at one half the length of a segment, and their depth about one eighth or one ninth the width.

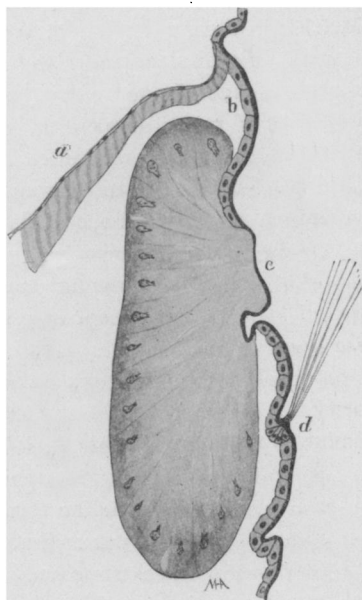


FIG. 2. Ventral section of a dermal gland; *a*, dorso-ventral muscle; *b*, epithelium; *c*, mouth of the gland; *d*, lateral fringe. Drawing by Miss Maud H. Anthony.

of a segment. The gland cells are wedge-shaped and are evidently modifications of the regular epithelium. Their nuclei are granulated and have small clefts pointing to the mouth of the gland. They lie along the inner edges of the cells. Numerous vacuoles occur throughout the gland. Concerning the function of these glands nothing was learned. Their absence in the pupal stage might lead us to infer that perhaps they were concerned in the process of metamorphosis, as is known to be true of the dermal glands of certain other insects.